OC4610 - WAVE AND SURF PREDICTION
LAB V: Hindcast Fetch Limited Wave Growth
Dec. 2, 2011

I. INTRODUCTION/BACKGROUND

In this week's lab students will compare Wavewatch III model results with observed data at sites off the North Carolina continental shelf. These data were collected as part of the SHOWEX field experiment conducted during the fall of 1999. Six wave buoys were deployed across the continental shelf in water depths of 20 to 200 meters (Fig. 1).

For the purpose of this lab we will examine observed and model data from one specific time during which winds were relatively steady in speed and direction over the study area and strong enough to be actively generating waves. The wind for this case study was offshore so featured significant fetch-limitations and refraction effects. Students will compare the observed data during a 3 hour window on Nov. 3 with model results generated using different source terms and swell input.

For this lab Wavewatch III was run using two different source terms (WAM vs. Tolman & Chailkov) and two different boundary conditions (swell as observed at site X6 vs. no swell). As you may recall from the discussion in class one of the differences between the two source terms is that in WAM energy input from wind is always positive or zero while in Tolman & Chalikov energy can be removed from the wave field if the waves are moving faster than the wind. Also, the WAM dissipation source term depends on the overall steepness of the waves and therefore is reduced in the presence of swell which have lower steepness than wind seas.

II. LAB GOALS/REQUIREMENTS

The purpose of this lab is to: 1) evaluate how well the Wavewatch III model predicts the observed conditions and 2) investigate how different model source terms (WAM vs. Tolman & Chalikov) and the presence of swell affect the model results in these conditions of relatively steady offshore winds. From the data provided create any plots necessary to address the following:

A) Create plots of the energy spectra (energy vs. frequency) and the mean direction vs. frequency for the observed data and model predictions. Compare the observed data at sites X-1 thru X-6 with the predicted data for each of the different model runs. Which set of source terms and boundary conditions most closely predicts the observed values? Do different source terms or boundary conditions work better in different frequency ranges or locations? If possible offer possible explanations for your observations.

B) Create plots of the buoy spectra (energy vs. frequency) at all the sites (X1-X6). Describe the evolution of the energy spectrum across the shelf. Try to relate your discussion to some of what you've learned in class concerning fetch limited wave growth. Plots of significant wave height may also be useful in the investigation of some of the above questions.

II. DATA

All the data for this lab can be found on the course web site, www.oc.nps.navy.mil/wavelab/courses/oc4610. Follow the link to labs, then to **Lab V Data**. The data files from each of the buoys sites X1 – X6 are named **spc_x1.mat , spc_x2.mat, spc_x3.mat, spc_x4.mat, spc_x5.mat, and spc_x6.mat.** Each of these files is a matlab ".mat" file containing the averaged spectral data over the three hour time period being studied. Data are contained in a structure named x1, x2, etc. The elements of this structure are:

a1 – the directional moment a1
a2 – the directional moment a2
b1 – the directional moment b1
b2 – the directional moment b2
fr – the frequency values
en – the energy values

Each of theses structure elements contains 64 values, one for each frequency.

The files of model results for each of the different source terms contain the spectral information for all the sites X1-X6. The format of these files is:

Row 1 – frequency
Row 2 – frequency bandwidth
Row 3 – energy spectra for the FRF 8m array (do not use)
Row 4 – energy spectra for site X1
Row 5 – energy spectra for site X2
Row 6 – energy spectra for site X3
Row 7 – energy spectra for site X4
Row 8 – energy spectra for site X5
Row 9 – energy spectra for site X6
Row 10 – mean direction for the FRF 8m array (do not use)
Row 11 – mean direction for site X1
Row 12 – mean direction for site X2
Row 13 – mean direction for site X3
Row 14 – mean direction for site X4
Row 15 – mean direction for site X5
Row 16 – mean direction for site X6

III. PROCEDURES/HINTS

The buoy data can be loaded directly into matlab using “**load(fle)**” where **fle** is the name of the “*.mat” file as described in section II. Once this is done the variable x1 (or x2,x3, etc.) will exist in the matlab environment and contain the elements as described above.

The model data may also be loaded into matlab, but these files are simple ascii files which will require the student to take some additional steps before the data are ready to use. Specifically the student must extract the appropriate rows of data to define the desired variables. For example: use the command **data=load(‘tol_ns_spec.dat’)** to load the model results for the Tolman & Chalikov no swell source terms, then **fr=data(1,:)** to extract the frequency data, **spc1=data(4,:)** to extract the spectral data for site X1, etc.

To calculate mean direction for the buoy data use the function “mean_dir”. This function returns the mean direction at each frequency when supplied with the directional moments a1, and b1. **(thm=mean_dir(a1,b1)).**

To calculate significant wave height use the function “sig_waveht”. This function will return the significant wave height (m) when supplied with either; 1) the structure x1, x2, etc. that was contained in the “.mat” file for the observed buoy data (example **swh=sig_waveht(x1)**) or 2) the energy spectra (**en**) and frequency bandwidth (**bw**) vectors from one of the model runs (example **swh=sig_waveht(en,bw)**).

Both functions “mean_dir.m” and “sig_waveht.m” can be downloaded from the course web site or can be accessed by running the matlab command **addpath(‘~jessen/oc4610/mfiles’)**.

For the energy spectra plots use semilog plots. (**semilogy(freq,en)**) where **freq** is the frequency and **en** is the energy density). When looking at the model runs with no swell input you will notice that the energy drops way off at lower frequencies. I suggest you change the axis limits on these plots to make them easier to interpret.

There are some example figures on the web site that may help you decide how best to look at the data.

Distances from shore (km) for the buoy sites are:

X1 – 5.4
X2 – 12.8
X3 – 22.2
X4 – 37.7
X5 – 58.2
X6 – 86.6

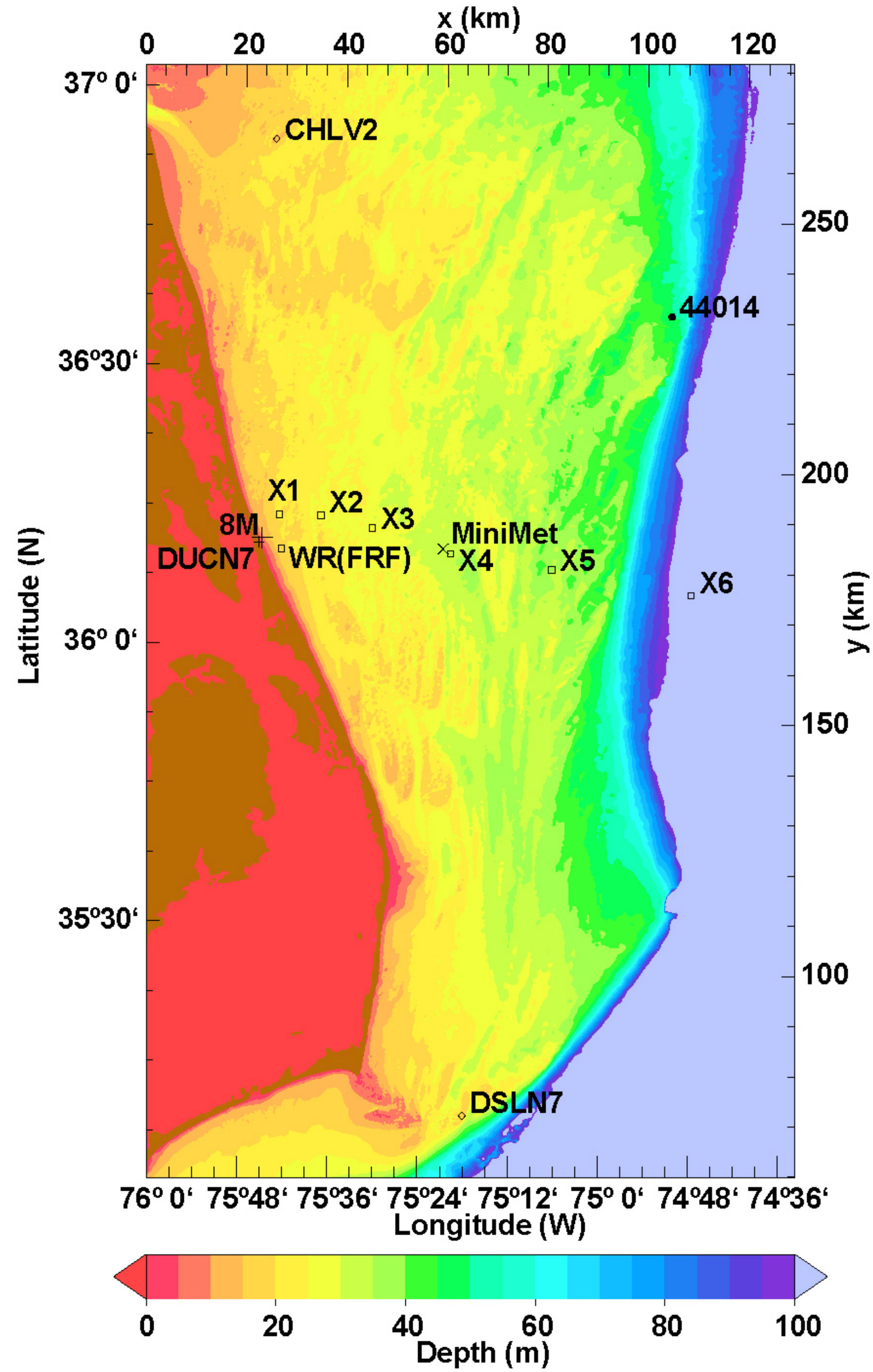

Figure 1 – Bathymetry of the continental shelf off the eastern mid-Atlantic coast of the United States.